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DEPARTMENT OF AGRICULTURE (HORTICULTURAL BRANCH).

SPRAYS AND SPRAYING.

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THE spraying of fruit-trees for the control of fungous and insect pests is of comparatively recent origin. Bordeaux mixture, which is one of the oldest fungicidal sprays on the market, was introduced into the United States in 1887. It is evident, therefore, that our present knowledge of the above topic is subject to change, and that we can hope to see in the near future better sprays, spray outfits, and systems of spraying than we have at present. The information given here is the consensus of the opinion of growers and instructors as to what is considered the best in these lines at the present time.

Some fruit-growers believe that in order to make their orchards productive it is only necessary to spray. Nothing could be more fallacious, as the causes of unproductiveness are many. When such causes are due to insect and fungous pests, spraying is, in most cases, a specific. When the cause of unproductiveness is poor soil, lack of tillage, poor varieties, etc., spraying can only have a secondary effect in correcting the barrenness of the plantation. In orchards which have been neglected in districts where orchard pests do serious damage, the owner should not expect to obtain perfect results the first year. Spraying being a preventive, in a large number of cases it is advisable to spray every year, especially in such districts as are mentioned above.

Economical and successful spraying does not depend altogether on methods of application, but depends to a marked extent on the condition of the orchard. Varieties differ in their blossoming and fruiting periods, etc., and as a consequence require sprays applied at varying periods, especially where some pests, such as apple-seab, brown-rot, and codling-moth, are to be controlled. In an orchard containing a large variety list per acre, successful spraying is made difficult and expensive.

Trees with high heads are hard to spray, and more spray is wasted in covering them than with a low-headed tree. Spraying accomplished from the ground is generally more thoroughly done than from an elevated position. These facts point strongly to the value of low-headed trees for economy and good results in spraying.

Spraying, especially in the case of some of our fungous diseases, has to be most thoroughly done, and all parts of the tree must be covered before satisfactory results can be obtained. A tree which contains superfluous wood will not produce the highest quality of fruits and is difficult to spray. This condition is also conducive to the spread of fungous diseases. Fruit-trees,

especially in the non-irrigated districts, should be kept well thinned out in order to produce high-quality fruits and make the spraying operations economical and successful. The relation of successful spraying to conditions in the orchard as mentioned above, i.e., low-heading of trees and pruning, are most important. They are conditions that are desired in a commercial orchard, so that the fruit-grower who keeps his orchard in good condition is in a position to obtain the best results in spraying.

A careful perusal of the circular on orchard pests will no doubt impress the reader with the value of knowing the pests he has to control, the use of correct mixtures, and the value of spraying at the right time. When the time comes for spraying, have everything ready, and do not delay the operation for something which might appear at a casual glance to be more important. A difference of a few days in application sometimes gives a difference of 50 per cent. or more in results.

The value of thoroughness in application cannot be overestimated. In controlling pests it is sometimes necessary to prevent the germination of "seeds" or spores, which are so small that they can be seen only by the use of a powerful microscope. From this, the value of thorough work is appreciated.

Sprays can be considered from the standpoint of effectiveness, cost, manufacture, effect on spray-machines, etc. In comparing the values of the sprays that are on the market at the present time, a large number can be discarded, which do not come up to the best ones when considered from the above factors. New sprays are being frequently advertised, and the growers are warned against their extensive use until they have been tried and proved safe, economical, and successful by the experiment stations. A great deal of damage has been done in the past through the use of new sprays before they had been thoroughly tested by the experiment stations.

INSECTICIDAL SPRAYS.

FOR THE CONTROL OF BITING-INSECTS.

Arsenate of Lead (Paste Form).—Two pounds to 40 gallons of water. Keep the arsenate of lead moist by covering it with water. Stir well the required amount of poison with a few gallons of water before adding to the spraying barrel or tank, so as to ensure a good mixture. For pear and cherry slug, 1 lb. of arsenate of lead to 40 gallons of water will be found sufficient.

Poisoned Bran-mash.—For use in the control of cutworms, etc. Mix well 1 lb. of paris green with 50 lb. of bran, and moisten to the consistency of fresh sawdust. Sweeten with a little sugar or molasses.

FOR SUCKING-INSECTS.

(1.) *Black Leaf 40, or Black Leaf.*—For summer spray the latter is diluted 1-60 with water. The former is twelve times stronger than the latter, so will require dilution accordingly.

(2.) *Whale-oil Soap and Quassia-chips*—

Whale-oil soap	1 lb.
Quassia-chips	1 lb.
Water	12½ gallons.

Boil the quassia-chips in 1 gallon of water for an hour. Dissolve the soap in hot water. Strain and mix both solutions together and dilute with water to make 12½ gallons of mixture.

Whale-oil Soap and Black Leaf.—A cheap and efficient aphid-spray is made by the following formula: Whale-oil soap, 2 lb.; Black Leaf, 1 quart. Dissolve the whale-oil soap as above and mix it with Black Leaf in 40 gallons of water. By adding 2 lb. of arsenate of lead to this formula it becomes an efficient spray against leaf-eating insects as well as aphids.

Besides the sprays mentioned above, lime-sulphur is used in the control of insects, especially the scale-insects.

FUNGICIDAL SPRAYS.

(1.) *Lime-sulphur.*—This spray, both for summer and winter spraying, is becoming very popular. It is an efficient fungicide, and also is useful in the control of many insect pests. It can be manufactured by the grower without infringement on any patent, but it is found at present prices of manufacture to be more economical to buy the commercial mixture. Most brands on the market have been giving good satisfaction, among which are some manufactured in our own Province. It is a good plan to have on hand a hydrometer (specific gravity and Beaume scale attached) to test the commercial mixture before using. The reading as given by the hydrometer is not always a sure indication of the strength of the commercial mixture, as something might be added which would raise the hydrometer test without increasing the fungicidal strength of the spray. With most commercial mixtures it can be used to advantage.

Dilutions.—The following is a table showing dilutions of different strengths of commercial lime-sulphur. This shows the dilutions which are giving the best results, and although they might seem a little strong, they are not too much so for aphides. There can be no injury from this strength for the dormant sprays, even when the buds are swelling. For summer spraying for apples and pears this is diluted with three and a half to four times as much water. For the tender foliage of plums and prunes use five to six times as much water.

TABLE FOR DILUTING CONCENTRATED LIME-SULPHUR SOLUTIONS.

Gallons	Hydrometer Specific Gravity.	AMOUNT OF DILUTION.	
		Number of gallons of water to one gallon of lime-sulphur solution.	For dormant spray.
36.....	1.310.....	1 gallon lime-sulphur.....	9.3 gallons water.
35.....	1.299.....	1 gallon lime-sulphur.....	9.6 gallons water.
34.....	1.288.....	1 gallon lime-sulphur.....	8.6 gallons water.
33.....	1.277.....	1 gallon lime-sulphur.....	8.2 gallons water.
32.....	1.267.....	1 gallon lime-sulphur.....	7.9 gallons water.
31.....	1.256.....	1 gallon lime-sulphur.....	7.5 gallons water.
30.....	1.246.....	1 gallon lime-sulphur.....	7.2 gallons water.
29.....	1.236.....	1 gallon lime-sulphur.....	6.9 gallons water.
28.....	1.226.....	1 gallon lime-sulphur.....	6.5 gallons water.
27.....	1.216.....	1 gallon lime-sulphur.....	6.2 gallons water.
26.....	1.206.....	1 gallon lime-sulphur.....	5.9 gallons water.
6.....	1.041.....	1 gallon lime-sulphur.....	0.4 gallon water.
5.....	1.034.....	1 gallon lime-sulphur.....	0.1 gallon water.

Some growers think it better to add some lime. This is not necessary, as it does not strengthen the spray, but in some cases it is supposed to have the opposite effect. When it is added, it is advisable to use the spray within a few hours after mixing or it will deteriorate.

In storing commercial lime-sulphur, it should be kept in a tight container, as it deteriorates when exposed to the air for some time.

Self-boiled Lime-sulphur.—For the summer spraying of peaches, apricots, and plums for peach-scab, peach-mildew, apricot-scab, and brown-rot of plums this mixture is to be recommended. It may be prepared as follows:—

Fresh stone-lime	8 lb.
Sulphur (Flour, or Flowers)	8 lb.
Water	40 gallons.

This is best prepared in quantities of 24 or more pounds at a time. Place 24 lb. of lime in a barrel, add enough cold water to keep the lime slaking well, and dust 24 lb. of sulphur, which has been first worked through a screen to break the lumps, over the lime; then add enough water to complete the slaking. Stir well with a hoe to prevent the lime from caking on the bottom. As soon as the slaking is over, add enough cold water to cool the whole mass and prevent further combination of the lime and sulphur. Dilute with enough water to make up the strength of the above formula. Strain diluted mixture through sieve into spray-tank and agitate well when using.

Dry Sulphur is sometimes used as a fungicide to check the spread of mildews and brown-rot on plums, cherries, etc. For this purpose it is dusted on the tree, or vine, when the disease is first noticed. It is doubtful whether this is practicable on a large scale.

Potassium Sulphide (liver of sulphur) is sometimes recommended for the control of mildews. Use 3 to 5 oz. of the above to 10 gallons of water. It does not spot the foliage or fruit.

Ammoniacal Copper-carbonate.—Sometimes used where spraying is necessary when fruit is nearing maturity. Use 5 oz. of copper-carbonate with just enough ammonia to dissolve it. Dilute with 40 gallons of water. If the ammonia is very strong it is advisable to dilute it with water before adding to the copper-carbonate.

Where Bordeaux mixture is to be used in quantity it is advisable to make stock solutions. To make a stock solution of copper-sulphate, put 20 gallons of water in a 40-gallon barrel; place in sack (preferably of a coarse nature, such as a light bran-sack) 80 lb. of copper-sulphate (bluestone); suspend this in a barrel so that the bottom of the sack is 5 or 6 inches under water. In a few hours, or at least a few days, the copper-sulphate will go into solution. Mark on the inside of the barrel the surface of the solution, so that if any evaporation takes place it can be replaced with water to make up the original quantity. After the copper-sulphate is all dissolved each gallon of the solution will contain 4 lb. of copper-sulphate. This proportion is given as an example, but any quantity can be used to suit the requirements of the maker. It is not desirable to dissolve more than is required for a month's use, as it will become weak through recrystallization at the bottom of the barrel and require dissolving again. Use only brass or wooden vessel as a container.

Lime.—Only good fresh stone-lime should be used. This can be made into a stock solution also. In slaking the lime, use just enough water to make it slake rapidly without being allowed to powder, which indicates burning through lack of water. Watch the lime carefully while slaking and keep it stirred. If the lime is not first quality, better results will be obtained through the use of hot water. If the above directions are carried out, the result should be a smooth white paste which, when water is added, will strain readily. Dilute the milk of lime with water, so it will be possible to know how many pounds of stone-lime is in each gallon of the lime-water.

Mark barrel to allow for evaporation, as in the case of the copper-sulphate solution.

After the stock solutions have been prepared, to make the 4-4-40 Bordeaux mixture, proceed as follows: Use two barrels besides the spray-barrel. In one barrel put 1 gallon of the copper-sulphate solution, which, according to the strength of the solution as described above, will contain 4 lb. of blue-stone. Dilute this to 20 gallons by adding 19 gallons of water. In the other barrel place stock solution of lime containing 4 lb. of lime, and dilute with water to make up 20 gallons. Stir both of these well and then pour them into the spray-barrel, so that the two liquids will unite as they enter. By following these directions carefully a Bordeaux mixture will be prepared which will stand in suspension well, stick well to the tree, and be effective. It is advisable to use this mixture within a few hours after making. It is advisable to strain the mixture as it goes into the spray-barrel. For this purpose a brass strainer fixed in a cone shape in the bottom of a pail with an outlet is very satisfactory. By pouring the mixture on the top of the cone it will strain readily with little clogging, and is more satisfactory in this respect than a flat strainer.

The following tests are good ones to show whether the copper-sulphate has all been neutralized by the lime:—

Potassium Ferrocyanide (in Solution).—No change on adding to mixture. If more lime is required, it turns a purple or reddish colour.

Blue Litmus-paper.—No change. If it turns red, more lime is required.

Knife-blade.—If metallic copper precipitates on the blade, the mixture requires more lime. The potassium ferrocyanide is the best and cheapest indicator.

Bordeaux mixture, double strength (8-8-40), is to be recommended for full spraying for the black-spot canker. The ordinary mixture is a valuable spray for potato-blight and various other vegetable-diseases.

Combination Spray.—A combination spray that is reported as giving excellent results in some sections of the Province is as follows: To 1 Imperial gallon of Kentucky Black Leaf add 79 gallons of water, and into this put 2 gallons commercial lime-sulphur 32° Beaume and 4 lb. of arsenate of lead. If "Black Leaf 40" is used, only one-twelfth as much need be used as of ordinary Black Leaf, for it is twelve times as strong. The above spray is used just after the blossoms have dropped, and is a valuable spray for killing aphides, locust-hoppers, leaf-eating caterpillars, and also is valuable as a third spray for leaf-scab and other fungous diseases.

Stick

Resin	2 lb.
Sul soda	1 lb.
Water	1 gallon.

Boil this mixture until it is of a clear brown colour, which takes from one to one and a half hours. Cook in an iron kettle in an open place. Add the above to 40 gallons of Bordeaux for use on smooth foliage, like onions, cabbage, or asparagus. If used with arsenate of lead or paris green, add 1 to 2 lb. of fresh lime to every 40 gallons.

SPRAYING MACHINERY.

The value of a spray outfit does not depend so much upon the work it is capable of doing as on the competency of the man using it. Just as good work has been accomplished and results obtained with a barrel hand-pump

as with a power-sprayer. Both good and poor work is being accomplished every year with all types, depending largely on the efficiency of the man in charge. With this in view it would be useless to go fully into the question of spray outfit and make any recommendations, as it is difficult to know whom the reader will be. However, there are a few general principles with regard to their purchase which are worthy of mention.

In selecting an outfit the fruit-grower should not select his type from the standpoint of his present necessities, but should consider his requirements for the near future, during at least part of the lifetime of the outfit. It should be simple in construction (so it will not require the services of an expert mechanic to adjust it), strong, easily worked, easily cleaned, and one in which high pressure can be maintained. This latter point, though possibly not of any great importance as far as the majority of our orchard pests are concerned, is important, as it influences greatly the labour cost of spraying. Double pressure decreases considerably the time required for spraying, and it will be noticed in the cost of spraying as given below that labour is an important item.



Nozzles of Bordeaux (flat spray) and circular spray type with angle.

Always wash out thoroughly the spray outfit after using. This will save a lot of trouble and time.

Some essentials in a good spray outfit are:—

- (1.) The pump, etc., should be simple, strong, and easy to adjust.
- (2.) The pump should be lined with brass, or some material which will not be corroded or rusted by the spray mixture.

(3.) The air-chamber should be of sufficient size to maintain a uniform pressure, and strong enough for high pressure.

(4.) A good agitator is required, as the fungicidal and insecticidal value of most of our sprays is contained in the fine particles held in suspension in the water.

(5.) A good strainer is necessary, especially where lime is used. The cone-shaped strainers have been found to be the most satisfactory.

(6.) Good strong hose only should be used. The best is none too good.

(7.) *Nozzles*.—Two types of nozzles are in common use and are giving good results—the Bordeaux type, which delivers a flat driving spray, and the Friend type, which delivers a circular spray. When spraying for codling-moth, or when winter spraying old trees with shaggy bark, bad crotches, etc., a high-pressure driving spray is best, and the Bordeaux nozzle is the one to use. For summer spraying when the chief object is to cover a large surface, or on young trees with a smooth bark, the nozzles which deliver a circular spray, as the Friend, Bean Jumbo, etc., are the most economical ones to use.

It is well to have the nozzle on the rod at an angle of 45 degrees, as this greatly facilitates spraying.

COMPARATIVE VALUES OF SPRAY OUTFITS.

Tables showing comparative values of spray outfits are given below. These will vary greatly according to the machine used, grower using it, age of trees, facilities for mixing, topography of land, etc. They are given as a basis for figuring values, and to show that the labour cost is the main item in spraying. The value of the larger outfits, other than shown here, is that less time is taken in the application of the spray, which is an important consideration, especially when fighting some of the pests, less labour is required per acre sprayed, higher pressure is obtained, and, as a general rule, more thorough spraying is accomplished.

BASIS: 50 BARRELS OF SPRAY.

(1.) *Barrel Hand-pump*—

Initial cost	\$25 00
Number of barrels per day, 8.	
Interest on investment, 8 per cent.	\$ 2 00
Depreciation in value, 10 per cent.	2 50
Six and one-quarter days, two men, @ \$2.50 ..	31 25
Six and one-quarter days, team, @ \$2	12 50
	————\$48 25

(2.) *Duplex Sprayer* (larger type or hand-pump)—

Initial cost	\$68 00
Number of barrels per day, 20.	
Interest on investment, 8 per cent.	\$ 5 44
Depreciation in value, 10 per cent.	6 80
Two and one-half days, three men, @ \$2.50	18 75
Two and one-half days, team, @ \$3.50	13 75
	————\$44 74

(3.) *Gasoline Power Outfit*—

Initial cost	\$400 00
Number of barrels per day, 40.	
Interest on investment, 8 per cent.	\$32 60
Depreciation in value, 10 per cent.	40 00

One and one-quarter days, three men. @ \$2.50 ..	9 37
One and one-quarter days, team. @ \$3.50	4 38
One and three-quarters gallons gasoline @ 30c...	53
	————\$86 25

BASIS: 200 BARRELS OF SPRAY.

(1.) Barrel hand-pump (one outfit. Would require two) ..	\$179 50
(2.) Duplex sprayer	142 24
(3.) Gasoline power outfit	129 10

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